The survival of newly-hatched leaf insects.

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Introduction

Leaf insects belong to the Phylliidae family of leaf and stick insects. They are only found in tropical Asia, Australia, and the Seychelles. There may be around twenty species of *Phyllium* (Brock, 1992: 46). The species we were studying was *Phyllium bioculatum* Gray. They are red upon hatching but turn green within three to seven days. They possess no defences such as sting, taste, etc. (as far as we know), relying on their ability to camouflage themselves against leaves. They are hatched from eggs which are laid at the rate of about three per day per female. Once hatched, the insects take 95-110 days to become fully grown, males maturing more quickly than females. Female leaf insects are heavy-bodied and flightless, while males are winged and fly freely. The average female will lay perhaps 500 eggs in her lifetime yet on average only two need to survive to maturity to maintain the population. What are the main biological controls that limit the population?

Red ants of the genus *Oecophylla* are common inhabitants of the trees which leaf insects use as their food plants. The ants make their nests by gluing leaves together with a kind of silk from the mandibles of their larvae, which they wield in their jaws. These ants not only spray formic acid from a modified sting gland but also use it in their bite, cocking the abdomen over the head and releasing acid onto the jaws (Skaife, 1979: 250). They will use their defences to protect their nests, or if they feel that there is a threat in the form of another insect in their immediate surroundings. Although their main food source appears to be "honeydew" from coccids, you also see them carrying small insects along to their nests. If you place a crumb of cooked chicken's egg yolk where they are foraging it is rapidly devoured and carried off by the ants. One frequently sees files of ants following well defined (to them!) paths along the trunk and branches of the tree on which they are living.

The purpose of this experiment is to observe the interaction of red ants with the leaf insects on their way up a tree, and to determine the seriousness of the threat that these red ants represent to the leaf insects.

Method

Eleven leaf insects, six of them were one day old and the remaining five newly hatched (seconds old), were individually released at the bottom of two adjacent mango trees, one of their natural foodplants (Woolman & Dharmasiri, 1995: 34). They were observed for their reactions to their surroundings, especially in their encounters with red ants which were considered likely predators. A map was drawn of one of the trees and the progress of the nymphs marked on it. Due to the problems of keeping track of the nymphs in three dimensions, however, this did not prove very useful. The weather at the time was unusually blustery and overcast with a temperature of 27°C.

It should be pointed out that the nymphs were being released into their natural habitat and that experience from many earlier releases suggested that they would cope successfully with most ant-contacts.

Observations

Nymph 1

The first leaf insect was released at the bottom of the first tree, where it remained still among the leaves. It remained there for about one minute, and then raced up the trunk of the tree to the leaves at the top, not stopping once on its way and not intercepted by any predators. It took about two minutes to reach near the top of the tree. At that point a gust of wind blew it off the tree trunk and we lost sight of it.

Nymph 2

The second one was released from the same spot, it slowly moved up about 5cm and then stopped, pausing for about two minutes. It then continued upwards, about 5cm further, and then stopped again for about the same amount of time. It continued this pattern all the way up the trunk, pausing sometimes for over five minutes at a time. At times it seemed to be in danger of being blown off by the wind. This insect too faced no opposition from other insects on its way up the tree.

Nymph 3

The third one released on this tree did encounter a red ant, the ant seemed to nibble at the leaf insect's leg for a second or two, and then the ant moved on, leaving the leaf insect alone. The nymph moved on and found a leaf quite low down on the tree where it crawled onto the underside and stayed for at least an hour (when we stopped our observations).

Nymph 4

This one paused 35 seconds and then climbed up steadily. It met an ant trail and almost got attacked but backed off quickly and escaped. It moved more or less horizontally around the tree to the right, paused for a minute and a half and then resumed its climb upwards safely.

Nymph 5

This one climbed steadily up the trunk and onto one of the lower branches. It crossed an ant trail unnoticed by the ants. It climbed up higher than any of the others. It stopped for two minutes at a height of 10m and then resumed its ascent until we lost sight of it.

Nymph 6

This encountered no other insects at all on its way up. It went directly up the tree.

Nymphs 7-11

During the course of the observations, at 8.40am, three eggs hatched almost simultaneously, while two more hatched a minute later (a sixth hatched about an hour later). The hatching process was very swift. It took no longer than ten seconds for them to worm their way free of the eggshell. At this stage their abdomen was cylindrical and the colour almost black. They immediately scurried across the ground and up the trunk of the tree, climbing approximately one metre up before pausing, each in a slightly overhung spot, to expand their abdomens. They remained there for about 15 minutes by the end of which time their abdomens were the bright reddish (with a fine tracery of black lines) typical of a very young nymph. Three of them then continued on up the tree, pausing and stopping occasionally for a few minutes at a time. One of them encountered a red ant and immediately dropped off the trunk to escape. The other two reached the top without any interference. Of the remaining two, one waited 45 minutes before climbing on up, whilst the fifth one was still in its initial resting place over an hour later.

Discussion

How much of a threat do red ants really pose to newly hatched leaf insects nymphs? It seems as if the immediate threat is small, even though there was a large colony of red ants in one of the mango trees. All of the insects we released reached the top intact, only one of them (nymph 3) actually being detained by an ant and even then being left alone after the first nibble. This indicates only 9% experience any opposition at all. Out of about 150 nymphs released onto various trees in the school grounds only three fatal encounters were observed. The problem cases occurred when the leaf insect's path converged, at a shallow angle, with a busy ant trail. With such a wide area as a tree trunk, the chance of this is quite small. Additionally, there is a suggestion that ants and nymphs make different choices. There seems to be a tendency for ant trails to keep to the low-points on the bark whilst the leaf insect nymphs appear to favour the prominences. Certainly in our detailed observations, 11 out of 11 insects did not intersect any ant paths at a shallow angle. Surprisingly, when the nymphs crossed an ant-trail at right angles, they nearly always passed through unscathed. If they bumped into an ant they backed off swiftly, moved a little to one side, and then scurried forward again. This generally took them through the line before the ants registered their presence. It is likely that there is more to this than just the element of swiftness and surprise.

It is strange, given that these ants are generally thought of as predators, that when an ant did intercept a leaf insect the ant generally left it unattacked. The coloration and bearing of the nymphs is very similar to that of large soldier ants. They even hold their body off the ground the same way. It may be that the worker ants mistake the nymphs for their own kind in these brief encounters. A mimicry of this sort was suggested for *Extatosoma tiaratum*, another phasmid with ant-like nymphs, by Key (1970).

Ants are one potential predator of leaf insect nymphs but what about birds and lizards? It takes a couple of days for the nymphs' coloration to start to match that of the leaves. When they make the journey up their trees they are bright red, easy to spot by the human eye, and no doubt just as easy to spot by a bird or any other visual predator. Although they are harmless, does this red act as a warning colour, in an attempt to trick predators, as many other insects which are dangerous also have bright colours? The curling up of the abdomen in a scorpion-like fashion may add to this deception. On one occasion two nymphs were observed passing within 50cm of a garden lizard, *Calotes versicolor* (Daudin), on an adjacent branch; the lizard ignored them. If one thinks about it, being green would not help them on the climb up the tree, the trunk is not green and their movement would give them away. It should be noted that the red colour is not as conspicuous as one might think once the nymph has settled underneath a leaf. Many of the mango leaves have bright red spots and patches, perhaps in reaction to fungal attack, and the nymph becomes just one more red fleck in the leaf.

Their similarity to ants, and their bright colour, may be why so many of these insects seem to reach the top of the trees alive. The overwhelming majority of eggs hatch in the daytime, mostly before midday. Interestingly, if the young nymphs are released at night they are very reluctant to move on up the tree-trunk. After dark, warning colours and mimicry would be no help in avoiding tree frogs, geckoes, scorpions and other denizens of the tropical forest.

In the daytime, some of them seemed to be in no hurry to reach the top, pausing many times along the trunk, others climbed from bottom to top without a stop. This variability might help ensure that at least some of the nymphs survive the journey in any particular situation. The insects seemed to be attracted to shaded areas, possibly because these areas are usually caused by the presence of

leaves above them. Perhaps they can sense the shade and this is what guides them to safety. It seemed that the leaf insects knew where the leaves were, as if they could see the leaves with eyes. We several times watched a nymph reaching out at full stretch for a leaf just beyond its grasp.

On more than one occasion we observed nymphs being blown off the tree trunk. They are very thin and light and in a high wind could be carried almost any distance. The gene-pool may be kept mixed through having adult males that can fly but this would not help the species reach new habitats. Storm-blown nymphs could do so, and this may be an important dispersal mechanism.

Conclusion

We conclude that red ants, and other predators, do not pose a serious threat to newly hatched leaf insects. This may be because the leaf insects can see to avoid them, because of the leaf insects' bright "warning" colouring, or because of their striking similarities to the ants themselves.

Our study is limited to the hazards associated with the first few minutes of a leaf insect's life outside the egg. While there are common sense reasons to assume that this is a particularly dangerous time, it would be helpful to have some data on the remaining portion of the insect's life! The next step must to be to make field observations of eggs, juveniles and adults under wild, or semi-wild conditions.

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References

Brock, P.D. (1982) *Rearing and studying stick and leaf-insects.* The Amateur Entomologists' Society, Feltham, Middlesex.
Key, K.H.L. (1970) Phasmatodea (stick insects) in *The Insects of Australia*, Melbourne University Press. pp. 348-359.
Skaife, S.H. (1979) *African Insect Life*, Longmans, Green & Co., London.
Woolman C.H. & Dharmasiri H. (1995) Food plants for *Phyllium bioculatum* Gray in Sri Lanka. *Phasmid Studies*, **4**(2): 33-36.